UNITED STATES DEPARTMENT OF AGRICULTURE
U.S. Soil Conservation Service
Washington 25, D. C.

IBN-AL-AWAM*

A Soil Scientist of Moorish Spain

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Reprinted from the Geographical Review
Vol. XXXIII, No. 1, January, 1943
With the permission of the Editor

October, 1943

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Two hundred years ago the "Kitab al-Felahah" or "Book of Agriculture,"[1] of Ibn-al-Awam was rediscovered in the Royal Spanish Library of San Lorenzo del Escorial and hailed as the greatest of all medieval treatises on agriculture. For hundreds of years this work had been completely lost to the Spanish farmers for whom it had been written in the latter half of the twelfth century of our era. Other European countries had never heard of Ibn-al-Awam. The earlier Roman agricultural writings, including those of Spanish-born Columella, had been preserved in monastery libraries, but Ibn-al-Awam was a Moor. As long as the conflict between the Moors and the Christians remained fresh in their memories, church and state alike condemned everything Moorish, even their agricultural achievements. It must be remembered that the first Moorish invaders had found little remaining of the highly developed agriculture of Roman Spain; for the Goths had been in possession of the country for three hundred years when, in A.D. 711 the Moorish invasion swept over the peninsula.

While the rest of Europe was passing through the darkest period of the Middle Ages, Moorish cities were growing in wealth and power. Córdoba became a center of learning that attracted scholars from all parts of the world. The library there is said to have contained 600,000 volumes, including Arabic translations of the classics of Rome and Greece. By the eleventh century Spain was producing its own scientific literature, in caliber rivaling, and in some ways surpassing, that of Rome. Among the Moorish writers agriculture was a favorite subject because of its religious implications. According to tradition, Mohammed himself said: "Whosoever plants or sows something and from the fruit of his trees and soil would feed men, birds, and wild beasts--all of this will be judged as charity."[2] To this he added that Allah rewarded each farmer "in proportion to the riches that the fruits of the soil would produce for him."

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*This paper is one of a series on pioneer soil conservationists of the western Mediterranean region. Others included in the series are Cato, Vergil, Columella, Pietro de Crescenzi, Leonardo da Vinci, and the Paulini brothers of Venice.

[1]Yahya ibn Muhammad (Ibn-al-Awam): Libro de agricultura: Su autor el doctor excelente Abu Zacaria Iahia Aben Mohamed Ben Ahmed ebn el Awam, Sevillano, translated into Spanish and annotated by Josef Antonio Banqueri, 2 vols., Madrid, 1802; idem: Le livre de l'agriculture, translated from the Arabic by J.-J. Clément-Mullet, 2 vols. (in 3), Paris, 1864-1867. Although catalogued in most libraries under the name Yahya-ibn Muhammad, the author is more generally known as Ibn-al-Awam or Abu-Zacaria.

The "Encyclopaedia of Islam" (under Ibn al-'Awwām) says: "Practically nothing is known of the life of this author...Casiri in his Catalogue [1760-1770] was the first to call attention to the complete manuscript preserved in the Escurial." See also the reference to Moncada, who, from the Leiden manuscript, published a translation of some missing pages.

[2]Ibn-al-Awam: Le livre de l'agriculture, Vol. I, p. 3. All quotations in this article are from the French version of the manuscript.

Ibn-al-Awam, in consequence, had a rich store of knowledge to draw upon. A century before his time Ibn-Hajaj had written a comprehensive treatise entitled the "al-Mongnâ," or the "Sufficient One"; a generation later the writings of Abu'l Khair included a bibliography of 1400 titles, all works of Spanish Moors. Haj of Granada preceded Ibn-al-Awam by half a generation. Like many other Moorish writings, however, those of Haj were lost--possibly after the fall of Granada when the overzealous Cardinal Jimenez ordered the destruction of all Moorish manuscripts or in 1671 when the Escorial Library burned.

To this written record of agricultural accomplishment Ibn-al-Awam added his own practical experience. No methods of crop culture were included in the "Kitab al-Felahah" unless Ibn-al-Awam had tested them thoroughly. His own lands were in the province of Aljarafe near Seville, an area regarded as the garden spot of Andalusia. The population here was not dense, and further extension of agriculture along sound scientific lines was possible if crops were selected in relation to the soil and the slope of the land. Ibn-al-Awam maintained that basically the nature of the soil determined what could or could not be grown. The nature of the soil, in turn, depended on the rock from which it had been formed, the slope and drainage of the land, the extent to which natural erosion had removed surface particles, and the modification of the soil by cultivation or by its natural vegetation.

In the first sentence of the "Kitab al-Felahah" Ibn-al-Awam says:

"The first step in the science of agriculture is the recognition of soils and of how to distinguish that which is of good quality and that which is of inferior quality. He who does not possess this knowledge lacks the first principles and deserves to be regarded as ignorant." (Vol. I, p. 23)

He then continues with an explanation of the principles of soil formation. All soil, he says, is derived from rock. When the rock is exposed to the sun and rain, it begins to disintegrate.

"In fact, the sun dries up the rock and divides it into parts, as fire does. Then comes the rain, which removes the particles that are small enough to be transported, until eventually the entire corroded mass becomes soil."

As the process continues, different types of soil gradually evolve as a result of their physiographic position. Because land utilization is one of the chief factors in both maintaining and modifying the nature of the soil, Ibn-al-Awam never describes soils without relating them to crops or methods of cultivation.

The best of all soils, he says, are the alluviums of the river valleys and islands,

"because of the mud with which they are mixed, for the running water brings sediment removed from the surface of the soil along with dead leaves and manure." (Vol. I, p. 26)

When mixed with the soil that has developed in place and with decomposing vegetable matter, the alluvium assumes a soupy consistency that is neither sticky when wet nor hard when dry. Soil of this type is limited in its distribution and available to but few farmers.

At the other extremity are the hard or rocky soils of the mountain slopes, where even the surface layer is of poor quality. Ibn-al-Awam explains the difference on the basis of erosion. The fine particles have been removed, leaving only a thin layer of soil mixed with coarser materials and rock. Such soil cannot retain the moisture necessary for plant growth and becomes as dry as desert sand during the rainless Spanish summers. If higher lands are to be cultivated, he recommends that farmers select plateaus rather than mountainsides, because of their deeper and moister soil.

Lowland plains are more desirable than the plateaus, however, if they possess enough slope to prevent water from stagnating. The rain water, which robs the slopes of their soil, enriches and refreshes the lowlands. To the farmers looking for deep soil, Ibn-al-Awam says:

"Always give preference to the soil of the plain rather than to that which is elevated, because rain water always flows towards the former, transporting in its flow that which has been removed from the high places." (Vol. I, p. 33)

He points out, however, that if rapidly moving water transports sand in place of silt, deposition may ruin agricultural land.

Although he appreciates the role of erosion in soil formation and distribution, Ibn-al-Awam also recognizes that the texture is in part determined by the underlying rock. Some rocks weather to clay and others to sand. Agriculturally, sand has little value, unless "it acquires a new consistency by the application of manure and the freshness that the water gives it" (Vol. I, p. 38). Normally the water penetrates through sand so rapidly that little is left for crops. Clay, on the other hand, becomes sticky when wet, and if the land is level, the water stagnates on the surface. On slopes it runs off without penetrating to the roots of the plants. In dry seasons clay bakes to a stonelike consistency and cracks, leaving its surface looking like "broken pottery." Roots have difficulty in growing downward into the compact clay, and young shoots in breaking through the crust.

The most desirable texture is a loam that absorbs and retains all water, "whether it came from the sky, as rain, or from the land, by irrigation" (Vol. I, p. 25). In nature erosion and deposition blend soils of different textures. The process was duplicated by the Moors, who systematically mixed clay with sand and sand with clay, thus improving the texture of each and reducing both runoff and erosion. Columella mentions this practice, but Ibn-al-Awam gives it far more emphasis, advocating the mixing of soils on both irrigated and unirrigated land.

When a slope is cultivated, the sediment that accumulates at its base should be collected and restored to its original position. In orchards, Ibn-al-Awam recommends that all the sediment be concentrated in the holes or trenches in which the olives or vines are planted. In addition,

"one should also place some wood and some stones beneath the tree and across the face of the hill by which the soil may be entrapped and be held there to accumulate as it is swept down onto the declivity. (Vol. I, p. 188)

Ibn-al-Awam had tested these practices on his own young olive trees with great success.

Natural vegetation, like mixing, alters the character of soils and tends to make them more resistant to erosion. Roots penetrating into clay aerate it and make it capable of absorbing larger amounts of water. Humus, added to sand by the vegetation, enables it to retain water longer. As the soil improves, vegetation becomes denser and more vigorous. In this way a naturally poor soil may eventually become capable of producing crops.

Soils of similar texture, however, differ greatly in productivity and appearance. Soils formed over limestone, Ibn-al-Awam notes, are red in some areas and black, yellow, brown, or white in others. Of these, a black soil formed from soft limestone (the rendzina of modern soil science) is considered best, because it can produce abundant crops of practically all cultivated plants. In quality it ranks but little lower than the alluviums, but, like them, it is not widely distributed. The more widely distributed red and yellow soils, although less fertile, are nevertheless suitable for most crops. Often, however, they are underlain by a clay subsoil. If the clay layer lies but a foot or so below the surface, the land is to be reserved for sown crops. A depth of three feet is necessary for trees, four feet for vines.

All soils, Ibn-al-Awam states, are underlain by a layer that differs radically from that at the surface, because of the movement of water within the soil. Such subsoil is found everywhere and can be said to form "one of the layers of the globe" (Vol. 2, Part I, p. 5), but its character is not always the same nor its depth below the surface. Where sand is underlain by clay, deep plowing that mixes the two layers improves the texture and increases the depth of the cultivable soil. Before applying deep plowing to any land, however, Ibn-al-Awam recommends:

"One must also take into consideration the depth of the soil, for it often happens that its surface layer may be black while the subsoil is white; sometimes the opposite occurs. (Vol. I, p. 336)

Throughout the text he repeatedly refers to differences in color between the upper and lower layers of soil. On occasion, deep plowing may materially reduce the productivity of the land by exposing a sterile subsoil. One of the reasons for the poor soil characteristic of hillsides is the removal of the topsoil and the consequent exposure of the subsoil. Shallow plowing is specifically recommended if a white efflorescence appears on the surface of the soil. This is an indication of the presence of salt resulting from faulty irrigation. After a shallow plowing the soil is to be flushed with fresh water, covered with straw, and allowed to remain idle for a season or longer. Thereafter it is dunged and again brought into cultivation.

Although Ibn-al-Awam describes a wide variety of soils, making fine distinctions between the different types and between the qualities possessed by the surface soil and the subsoils, considerable difficulty is encountered in interpreting his discussions in the light of modern soil science. Even today there is much controversy concerning Mediterranean soils, and the adjectives, particularly of color, used to describe them have never been standardized. Language also interposes obstacles. Ibn-al-Awam wrote in Arabic, a language capable of conveying fine distinctions in meaning. This was translated into the far less flexible Spanish and French.[3] No complete English translation has ever been

[3]Because of the translators' interpretations and omissions, often resulting from religious principles, the Spanish and French editions do not agree in all details.

published. Reference to the original Arabic manuscripts would undoubtedly clear up many ambiguities and apparent unconsistencies and contradictions that appear in the available translations.

On the subject of soil amendment there is far less ambiguity. Ibn-al-Awam agrees with Columella and other Roman authors in recommending the use of all types of dung, in distinguishing between their relative merits, and in describing the manufacture of compost from household and farm waste. Whereas the Romans applied fertilizer to all cultivated land, both irrigated and unirrigated, the Moors reserved manure and compost for irrigated plots.

Ibn-al-Awam comments on the difficulty of obtaining sufficient manure for large fields. As a substitute he employed rotations and plowing. Wheat and barley, he says,

"greatly fatigue the soil when they are grown repeatedly without interruption. If, then,we do not wish our soil to be exhausted by wheat and barley, we alternate crops; in this way we preserve its productive power for a long time.... Thus we must employ (reasonably) the nutritive power to secure rest for the soil, notably by sowing legumes. The ancients approved of this system." (Vol. 2, Part I, p. 13)

The value placed on legumes by the Moors is indicated by the large number mentioned by Ibn-al-Awam and by the care devoted to describing methods of cultivation. Among the legumes listed are the lupine or Roman rocket, numerous kinds of beans, lentils, vetch, peas, fenugreek, and clover. All of these are recommended for rotations, to be planted without manuring, since the legumes themselves serve in place of dung. Most of them were raised on both irrigated and unirrigated land for the purpose of improving the soil.

Qath, or alfalfa, is in a somewhat different category. A single planting, says Ibn-al-Awam, often lasted as long as twenty years. After the mowing, it was "irrigated, and the roots remaining in the soil sent forth a new growth" (Vol. 2, Part I, p. 127). The length of stand combined with its excellence as a fodder limited the use of alfalfa for rotations. To the Moors alfalfa was "the best or the queen of all fodders" and was used particularly for feeding their highly prized Arabian steeds. Land that had produced alfalfa was considered better than any other for subsequent crops.

In their system of plowing to improve the quality of the soil the Moors anticipated Jethro Tull by at least five hundred years. Both recommended deep and frequent plowing, so that the soil might benefit from exposure to sun and rain. Both held that plowing accomplished the same ends as manuring, but to Ibn-al-Awam plowing and rotations were inseparable, and the rotations he describes invariably include legumes. He notes also that plowing conserves moisture by keeping the soil porous and helps to maintain its fertility by killing weeds that abstract nourishment from the soil. The similarity between Tull and Ibn-al-Awam was recognized when, in 1751, Chapters 17 and 19 of the "Kitab al-Felahah," the chapters dealing with plowing, were appended to the Spanish edition of Tull's writings.[4]

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[4]Yahya ibn Muhammad, Libro de agricultura, Vol. I, preliminary discussion p. 12

The Moorish cycle of plowing was known as the "qalib", and the value attached to it is indicated in their proverb "He does not till who does not practice the qalib" (Vol. 2, Part I, p. 8). The qalib, which was applied primarily to unirrigated fields, required a minimum of three plowings before the planting, the dates varying according to the time of planting, the distribution of rainfall, and the nature of the soil. For heavy soil four plowings were necessary; a light soil might need no more than two if some leguminous crop had preceded the plowing.

For field crops, land was selected that had lain fallow or produced a summer crop of legumes. Occasionally wheat was sown on barley stubble or vice versa. For spring planting, the land was first broken in December or January and plowed again in March. In May it was given a final plowing in preparation for the planting. The soil was never plowed while it was still wet after a rain, since plowing then would destroy the soil structure and reduce subsequent crop yields. Evidently Ibn-al-Awam also recognized the danger of wind erosion, for he advises farmers to plow only in "calm weather" and warns against plowing when the soil is dry and powdery. If the spring crop was a legume, grain could be planted in the fall directly after the harvest, and the number of plowings was reduced.

The qalib differed from the Roman cycle of plowing in two respects: emphasis and the insistence on rotations that included soil-building crops. To the Romans, each plowing was a complete operation in itself; to the Moors, the work was not complete until the conclusion of the final plowing, when the soil was ready for the planting. By reducing the annual cycle of plowing to a ritual, the Moors ensured a continuity of effort that resulted in meticulous care of the soil throughout the entire year. Their use of legumes in rotations not only helped to maintain a favorable, crumblike soil structure but also periodically replaced nitrogen that had been removed by cropping. Although not specifically directed toward erosion control, the qalib resulted in the maintenance of the structural and chemical properties of the soil that served to reduce the erosion hazard.

Ibn-al-Awam describes in detail the method for erosion control on irrigated land. Here erosion would not only remove the soil and valuable manure but also render useless the time and labor that had been expended on the land. The land was first leveled. Thereafter, irrigation and drainage ditches that cut across it were given a slight gradient, so that the water would circulate, but without sufficient force to erode the land. "Otherwise," says Ibn-al-Awam, "the water will carry both seeds and manure from the higher to the lower elevations" (Vol. I, p. 133).

Two instruments were used for leveling the land--the plumb level and the alidade. When the level was used, the boundaries of the irrigated plot were marked off first. Two stakes or poles were then driven into the ground vertically, care being taken that the parts that protruded above ground were exactly equal in height. A line was stretched from the top of one stake to the top of the other, and a plumb level was suspended at the middle point of the lines. If the plumb bisected the scale of the level exactly, the two stakes were at points of equal elevation. If not, soil was removed from higher places to fill in depressions. The process was repeated until the entire irrigated plot had been made level. No description is given of the level, but it was probably a variation of that described by Columella. [5]

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[5]Columella, De re rustica, III, 13: II-13 (translation by M. C. Curtius: L. Iunius Moderatur Columella, Of Husbandry, in Twelve Books, and His Book concerning Trees, London, 1745, pp. 145-146).

The use of the alidade Ibn-al-Awam found even simpler. It was made by inserting two screw eyes into a board or by placing uprights with holes directly opposite each other at each end of a board. After setting the alidade on the ground in an absolutely horizontal position, the farmer sighted through the two holes at a stake driven into the ground some distance away. Anyone that lacked an alidade might, with a little practice, sight through a hollow tile or along the ridge of an inverted V-tile. A scale was marked on the stake, with heights conspicuously indicated, preferably in different colors, so that they could be easily distinguished at a distance. Sighting with the alidade, the farmer noted which marking was opposite his line of vision. The ground was then filled in to this height. A variation of this technique was used for ensuring a uniform slope for irrigation ditches. Any desired slope could be obtained by adjusting the alidade to some selected marking that lay below the line of vision. The slope recommended by Ibn-al-Awam was about 1 inch in 16.5 feet, or, approximately, a slope of 1 in 200.[6] To maintain a uniform slope of such gentle gradient with the crude instruments available at the time required both skill and accuracy.

Throughout the "Kitab al-Felahah" Ibn-al-Awam shows this same insistence on accuracy in detail and on thoroughness. In all, he mentions more than five hundred varieties of cultivated plants. The description of each plant is accompanied by a discussion of the best situations for its growth and methods for its cultivation. Equal care is devoted to the description of animals, methods of breeding, and the cures for common ailments. Details of the application of irrigation water are lacking, because they varied from place to place, according to the nature of the water supply, and because they were strictly regulated by Moorish laws, from which no divergence was tolerated.

To verify and expand his conclusions, Ibn-al-Awam quotes more than a hundred authors--ancient Nabateans, Greeks, Romans, and Carthaginians as well as contemporary Arabs--selecting from each only that which was applicable to the soils and climates of Spain.[7] Authors such as Columella and Vergil he cites by name because they lived before the time of Mohammed. He was too good a Mohammedan to cite Christians by name and too thorough a scientist to ignore their contributions. Therefore he said:

"I have introduced the opinions of men, strangers to Islam; I do not name them but have indicated them in a roundabout way by prefacing the passages cited with the words: 'Another has said' such a thing." (Vol. 1, p. 9)

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[6]Le livre de l'agriculture, Vol. 1, p. 131, Ibn-al-Awam recommended 12 fingers in 100 cubits. Hebrew measurements were used in converting fingers and cubits into inches and feet.

[7]The sources used most frequently by Ibn-al-Awam are the writings of Columella; the "al-Mogna," or the "Sufficient One," written by the Moor Ibn-Hajaj, in A.D. 1073; and the Nabatean Book of Agriculture. The last was purportedly an Arabic translation of a Babylonian manuscript written about 550 B.C. This has been questioned, but the work, whenever it was written, contains the earliest traditions of Arab agriculture.

Today the "Kitab al-Felahah" is generally conceded to be the most comprehensive summarization ever made of agricultural knowledge from the earliest times through the Middle Ages. It would have been of inestimable value to Spain had the Christians shown more tolerance. But even in an age of bigotry, efforts to preserve Moorish agricultural practices were not lacking. The broad-minded and progressive Ferdinand and Isabella, recognizing that the Catholic Cred and Moorish agriculture were not incompatible, determined to preserve the irrigation works of Granada, not only for the Christians but also for those Moors who were willing to abandon their faith. As early as 1513, Gabriel Alonso de Herrera[8] incorporated into his monumental compendium on agriculture the precepts of the Moors as well as of the classical authorities. But by his time, apparently, the "Kitab al-Felahah" had already been lost; for Herrera makes no mention of it or of cultivated plants such as cotton, rice, and the carob that had been introduced into Spain by the Moors and that were discussed in detail by Ibn-al-Awam.

By the time the work of Ibn-al-Awam was rediscovered, Spanish agriculture had sunk to its lowest depths. Herds of sheep, without restraint, had been driven across the land annually enroute to their summer or winter pastures. Farms and irrigation works had been ruined, and eriosion was so far advance that some of the crops described by Ibn-al-Awam could be grown only in limited areas. Ibn-al-Awam had prayed in vain:

"Praise be to Allah, the master of the world; that the prayer may be upon our Prophet, Mohammed, upon his family, upon his companions; and also peace. I pray that my work answer the end for which it was designed in the interest of the cultivation of the soil; That men who can understand it and grasp the meaning of it may meditate upon it and unite with their own work other isolated studies along with those that are here assembled." (Vol. 2, Part 1, p. 445)

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[8]Agricultura general, . . . corregida segun el testo original de la primera edición publicada en 1513 por el mismo autor, y adicionada por la Real Sociedad Económica Matritense, 4 vols., Madrid, 1818-1819.